

N. C. AGRICULTURAL EXTENSION SERVICE

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RALEIGH

THE OPTIMUM DIET

**With the Relative Importance in the Diet of
Vegetables, Fruits, and Milk**

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What should we eat in order to maintain vigor, promote health and vitality as well as growth? Although the question is old, the evidence and facts be presented here are new. They have been recently discovered.

FOOD; OLD IDEAS OF WHAT IT IS

It was not long ago that foods were judged solely by chemical analysis judged on the basis of the amount present of protein, fat, fiber and carbohydrates; in other words, on the amount present of sugar, fat and tissue-build material.

A little later investigators went further and estimated foods on the caloric basis or energy content, just like buying coal on the basis of the amount of heat given. With this situation in mind, let us consider the status of experimental feeding side with laboratory animals.

Investigators were able to maintain for a few weeks only a small laboratory animal on such a purified diet of fat, protein, carbohydrate, chemically pure salts, and also distilled water. Before 1906 the longest period on record on such a diet was 30 days. These animals did not breed, reproduce nor rear their young. Investigators were confronted with great difficulties; the animals did not thrive. They got sick and died. It is only recently that wild animals kept in captivity have been able to rear their young. Before this they always died, and no one knew what was the matter. A lion or tiger fed meat in abundance was expected to have a sufficient diet to enable her to rear her young.

Many views about diets were held before this time, such as palatability that a diet had to be palatable in order to make a small laboratory animal grow. Now such animals have been successfully maintained on a most monotonous diet through the fourth generation, together with the rearing of young of this generation through the weaning stage.

WHAT IS FOOD? THE NEW IDEA

It is a long story of how a little evidence here and there was gathered together of the rice diet in the Philippines, a little from the Japanese ration found necessary to prevent Beri-beri, a little on the use of polished rice in China, and a little from a university laboratory in England where 1 or 2 cc. of milk was daily fed with a highly purified diet to white mice with wonderful but unexplainable results. All this was pieced together and resulted in the well planned, long experiments by E. V. McCollum, at the University of Wisconsin, which gave the clue to the difficulties. This situation has revolutionized the most conservative views in diet and nutrition.

Our attention is now confined more to a *complete* or *essential* diet for growth, vigor, reproduction, lactation and the prolongation of the characteristics of youth and the warding off of those of premature senility. These sensitive physiological tests or indexes of the effects of diets. I thus prop

ask of an *optimum* diet and its essentials instead of the usual or *normal* diet. Time and again we have fed animals all they would eat, yet they ultimately died. They did not grow on a "quantity" diet alone. It is necessary to consider the "quality" of the diet, especially the quality of the protein. A biological analysis of it; that is, by carefully controlled feeding experiments on small animals. Such experiments have confirmed the chemical demonstration of the quality, or difference, in the proteins themselves, that some are better than others, *e. g.*, milk curd or casein is superior to gelatin. It is composed of more building stones, or the chemical units necessary to construct the body tissues.



Fig. 1.—Quality of Proteins in the Diet. The rations of these two rats had the same composition as shown by chemical analysis. They differed only in the source of the protein which they contained. The rat on the right grew up on a mixture of proteins from the corn meal and wheat gluten; that on the left on a mixture of corn proteins and gelatin. The difference in size, and remarkable difference in appearance is solely the result of the difference in the quality of the proteins in the two diets.
(reproduced from McCollum's "Newer Knowledge of Nutrition," The MacMillan Company, Publishers.)

In addition to carbohydrates, protein, fat and minerals, it has been recently found that three other chief essentials are necessary for an optimum diet. They are: a good quality of protein, an adequate supply of fat-soluble A, and calcium.* The lack (or less than the minimum essential amount) of any one of these three factors will limit growth. And in a laboratory animal at least, will prevent reproduction or the successful rearing of young.

RELATIVE IMPORTANCE OF FOODS—SOURCE OF CHIEF FOOD ESSENTIALS

Milk and Its Products

It was found that the milk elaborated by the mammary gland for the purpose of nourishing the young contained a virtue, or subtle substance new to science—the fat-soluble A.

This occurs in relatively large amounts. The proteins of milk are of high quality. They are growth-promoting. Calcium is present in abundance. This substance is necessary for skeleton-building. It comes second to proteins in amount in the body. The lack of calcium associated with other factors in the diet of infants and children, causes rickets or malformation of bone.

*The need of the widely distributed water-soluble B will not be discussed. It occurs abundantly in seeds, milk and yeast. In this part of the world where polished rice does not constitute the chief cereal in our diet, it is present in our usual diets in adequate quantity.

Milk with its excellent proteins, high calcium and fat-soluble A complements the cereals with respect to these three essentials—protein, calcium and fat-soluble A. It contains, therefore, an abundance of these deficiencies factors necessary for growth. It occupies a unique as well as an important place in the diet.

Seeds, Cereal Grains, Leaves

Biological analysis also showed that the cereal grains or seeds differ from the leafy portion of plants. The seeds alone do not promote growth. Supplementing them with the leafy portion does. In this respect the leafy portion



FIG. 2.—Effect of Fat-soluble A on Growth and Condition of Well-being. The rats of these two rats from weaning time were exactly alike, except in the character of the fat they contained. The one on the left was given 5 per cent of sunflower seed oil. The one on the right was given 1.5 per cent of butter fat.

(Reproduced from McCollum's "Newer Knowledge of Nutrition," The MacMillan Company Publishers.)

of plants resembled milk and butter. This led to the discovery of certain food essentials in them which before this had been found in butter fat—namely, the fat-soluble A, or vitamine which is necessary for well-being, health and growth.

It was learned that seeds of all kinds being chiefly storage organs contained little of this food essential. The small traces of fat-soluble A present were found to be present in the germ part. But the other parts of the seed, especially the leaves, the most active synthesizing part, were found to be rich in milk in that they are necessary to further fruition and reproduction, and that they contain these food essentials in abundant amounts.

The cereals (flours and meals) are not only deficient in fat-soluble A and calcium, but also deficient in the quality of protein. In respect to quality of protein, wheat ranks highest among the cereals; corn, peas and beans lowest. The other chief cereals fall in between.

In brief, in the usual cereal diet, there is lacking a good quality of protein, fat-soluble A, and calcium. Sodium and chlorine must always be supplied.

Roots, Tubers, Vegetable Oils

Roots and tubers being functionally essential tissue-storage organs are like the seeds. They contain little or none of the food essential fat-soluble A. Neither do the vegetable oils derived from seeds contain any.

Fruits

Citrus fruits, such as oranges and lemons, as well as the others, furnish the anti-scorbutics. The use of fruits prevents scurvy in growing children. It is well known that infants and children are more prone to scurvy than the adult. The adult is also subject to scurvy, and this food essential has to be added in the diet. Green vegetables may supply it. As a rule children will eat fruits more readily than green vegetables. The fruits, in addition, are palatable, and furnish roughage or fiber, as well as mineral salts.

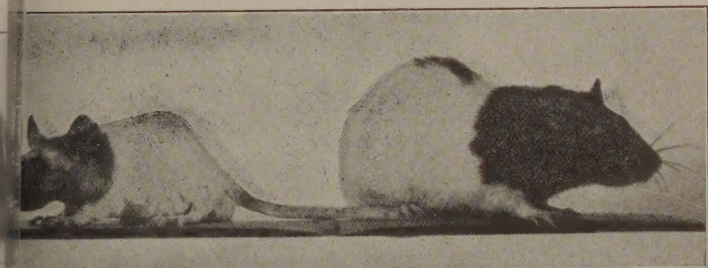


FIG. 3.—Effect of Fat-soluble A on Growth and Health. From weaning time the rations of two rats were identical, except in the character of the fats which they contained. The rat on the right was given 1.5 per cent butter fat in its diet, while the one on the left was given 5 per cent of bleached cotton seed oil. The former grew at the normal rate, while the latter remained stunted, and suffered loss of hair and emaciation. (Reproduced from Cum's "Newer Knowledge of Nutrition," The MacMillan Company, Publishers.) The small rats in Figures 2 and 3 had not yet developed xerophthalmia when photographed.)

Meat, Muscle, Internal Organs

Let us consider the body tissues, the muscles, fats and internal organs. The muscles contain no fat-soluble A, neither as a rule do the animal body fats. This is more particularly true of the manufactured or refined commercial products. However, the glandular organs of the body are rather rich in these essentials, especially the kidney and liver.

In respect to meat, what is its place in the diet? It has been largely used from time immemorial. There must be some virtue in it. Muscle consists chiefly of protein—completely digestible and very palatable. Meat, however, has certain deficiencies. The Polar bear on catching a seal or walrus, does not eat the muscle meats first. He rips open the belly and eats the internal organs and the blood. Meat is deficient in fat-soluble A as well as in calcium.

What is the relation of the muscle meats to the vegetable foods? Will these meats supplement the vegetables in the diet? In one respect they will, especially as regards the meat proteins. The vegetable proteins are relatively inferior in quality. But internal glandular organs, such as the Polar bear eats, when used in connection with vegetable foods, serve to enhance the vegetable proteins as well as to supply the deficient fat-soluble A which they contain. Calcium will still be lacking in the diet. Sodium and chlorine are always lacking, and are supplied as sodium chloride or common salt.

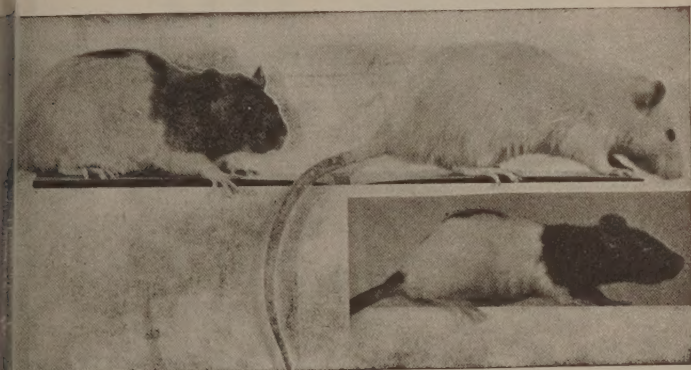
Meat also supplements the proteins of the cereals, and in this respect fills their deficiencies.



This photograph illustrates the Food Supply.

Leafy Vegetables

Leafy vegetables served as salads, or as "greens," supplement our ordinary cereal diet, in respect to fat-soluble A. They also furnish roughage necessary to stimulate the intestinal tract.



—A Strictly Vegetable Diet with Leaf Included. This photograph shows the degree of growth which has been attained in securing growth, reproduction and rearing of young in an albino animal, the rat, with a diet of strictly vegetable origin. Maize 50 per cent; leaf (dry) 30 per cent; cooked dried peas (dried subsequently) 20 per cent. This photograph rates that successful diets of plant origin can be secured only when the leaf of the plant is a prominent constituent of the diet. The albino and her daughter are shown above, and her granddaughter below. Young of the third generation were successfully reared, with no apparent diminution of vitality. (Reproduced from McCollum's "Newer Knowledge of Nutrition," The MacMillan Company, 1918.)

SUMMARY

—The importance of the constant daily use of milk in the diet has been pointed out. Milk supplements the usual cereal, potato, meat diet in the three deficiencies, excellent protein, fat-soluble A and calcium.

Grains, Meals, Flours, Roots, Tubers.—The seeds, cereal grains, roots and tubers are deficient in calcium and fat-soluble A. So are the vegetable oils. The proteins in the above, that is, in our meals, flours, and potatoes are of fair quality. In general a mixture of the cereals in the diet does not give their quality in respect to protein. Roots and tubers possess the same quality of proteins as the cereals. Milk used in connection with such a diet supplements the usual cereals, including the meals and flours, supplies these deficiencies. The "greens" or the leafy vegetables with respect to fat-soluble A. Meats furnish a good quality of protein. Garden vegetables will supply a portion of the necessary calcium. Milk alone can supply adequate calcium.

Leafy Vegetables or "Greens."—"Greens" and the leafy vegetables furnish the necessary fat-soluble A and fiber. Their proteins are no better than those of the cereals. The cereal diet is then deficient in quality of protein and in fiber.

Fruits.—Fruits furnish anti-scorbutics and mineral salts.

Meats.—Meat furnishes an excellent protein—supplementary to the cereal and potato diet, but it is deficient in the food essentials, fat-soluble A, and calcium. Meat is so established in the diet that we need not emphasize it so long as its place in the diet is understood with respect to its deficiency. Internal organs, such as kidney, liver and sweet breads, should be more generally and widely used. They supply fat-soluble A as well as protein of quality.



FIG. 6.—Effect of Restricted and Defective Diets. This picture illustrates the emaciated appearance of a middle aged rat after being fed about four months on a diet consisting of bolted flour, corn meal, rice, sugar, starch, pork fat, molasses, sweet potato and cabbage. Such a diet has been reported by Goldberger to have produced pellagra in man in five and a half months. This diet affords wide variety and consists of wholesome food products but fails to maintain normal nutrition because it contains too little of the *essential foods*—eggs and the leafy vegetables.

(Reproduced from McCollum's "Newer Knowledge of Nutrition," The MacMillan Company Publishers.)

WHAT IS THE OPTIMUM DIET?

Thus our optimum daily diet should consist of the cereals and tubers such as bread, biscuit and potatoes, not alone, but together with milk, salad "greens" and vegetables, fresh fruits (or when not available, canned tomatoes may be substituted) and meat in moderate amount.

The attention to and application of these facts will prolong life, promote health and vigor, as well as ward off premature signs of senility or old age.

REFERENCES: "The Newer Knowledge of Nutrition," E. V. McCollum; J. Biol. Chem., 1921 (June), XLVII, pp. 111-248.